On recent massively parallelized PIC simulations of the SOL

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In this work we review recent results of massively parallel kinetic simulations of the tokamak SOL. They have been performed via electrostatic PIC+MC code BIT1, which models nonlinear dynamics of 1D plasma, 2D neutral and quazi-2D impurity particles in the SOL. BIT1 includes number of synthetic diagnostics allowing direct comparison of simulation results with the experiment [2]. Contrary to the existing kinetic models BIT1 can simulate (almost) a real size SOL with the finest resolution in time and space (down to electron gyro-motion). As a result, this model does not require any artificial boundary conditions, so that the particle distributions can be self-consistently calculated at each location.

We discuss briefly our previous results such as interpretation of divertor Langmuir probe measurements in the divertor plasma [2] and present new findings for a high recycling SOL. The simulated plasma parameters correspond to large size tokamaks. We demonstrate that number of well studied properties of the low recycling PWT (plasma-wall-transition layer) can not be generalized for the high recycling PWT. For example:

(i) The classical definition of the ion sound speed $c_s = \sqrt{\frac{T_e + \gamma T_i}{M_i}}$ can fail for high recycling PWT. This is the consequence of the fact that the polytropic coefficient γ becomes strongly nonuniform and can be even negative in such a PWT;

(ii) The average energy carried by the ions impinging on the wall does not necessarily show the classical scaling, $E \sim 2T_i + e\Delta\varphi$, where $\Delta\varphi$ is the potential drop across the plasma sheath. The reason is a strong deviation of the ion velocity distribution function in the plasma presheath from the Maxwellian one.

This (to our knowledge) worldwide unique attempt can demonstrate that the massively parallel kinetic modeling represents a powerful and challenging tool for realistic SOL study.

[1] D. Tskhakaya, A. Soba, R. Schneider, M. Borchardt, E. Yurtesen, J. Westerholm**,** proceedings of 18-th Euromicro Conference on Parallel, Distributed and Network-based Processing, IEEE, Computer Society, (2010) 476.

[2] D. Tskhakaya, S. Jachmich, T. Eich, W. Fundamenski and JET EFDA Contributors, J. of Nucl. Materials, in press, NUMA_45198 (2011).